Water metrics user guide: Vers3_July_2018

1 Background

The objective of the Voluntary Code of Practice (VCP) is to establish common water management practices among mining companies and to promote the efficient and transparent use of water. Within VCP 1.1, companies are required to: *Publicly report water risks, management activities and performance using recognized metrics.*

Upon signing the VCP, companies agreed to report on 12 specific metrics (see Annex 1), which are consistent with the government mandated Annual Environmental Monitoring and Implementation reports. The purpose of this user guide is to clarify requirements for reporting these metrics and ensure consistency in the way that water information is measured, monitored and reported across VCP signatories.

2 Categorizing water metrics

A key reason for developing the VCP was to address community concerns about mine site water use and associated impacts. It is therefore crucial that water metrics information is collected and reported in a way that facilitates community understanding. The IFC-commissioned community baseline survey identified two core concerns:

1. Widespread lack of trust in the mining sector's capacity to manage water resources; and
2. Fears that mining will impact the quantity and quality of water available to local residents.

The water metrics to be reported under the VCP can be grouped into two categories according to which community concern they address and the spatial boundary of focus (Figure 1). These two categories are: (1) water use by the mine site (addressing the first community concern relating to a widespread lack of trust in the mining sector's capacity to manage water resources), or (2) the state of the surrounding community and environment (addressing the second community concern regarding fears that mining will impact the quantity and quality of water available to local residents).

Water balance metrics
1. Pit dewatering
2. Quality of mine water use
3. Total water withdrawal per aquifer or per source (M^3/h) per year at mine site/camp and water balance of the company
4. Wastewater treatment and discharge

Water use efficiency metrics:
5. Volume of water used per mine resident (non-operational mine)
6. Total volume of water recycled and re-used at the mine/project

Water use by the mine site

State of the surrounding community and environment
7. Groundwater level and flow monitoring
8. Surface water level and flow monitoring
9. Rainfall and climate monitoring
10. Monitoring of local herder wells or springs near project site
11. Monitoring quality of local drinking water source
12. Water (ground/surface) quality monitoring around mine/camp

State of surrounding water systems

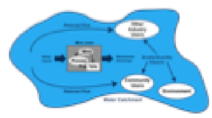

Figure 1. VCP water metrics have been organized into two categories

3 Water Use by the Mine Site

Metrics relating to *water use by the mine site* can address community concern about *a widespread lack of trust in the mining sector's capacity to manage water resources* through the following:

- Quantify the overall volume and quality of water that is used and discharged by a mine;
- Compare water use efficiency with other mines in the region;
- Benchmark water use efficiency with mines of the same commodity located in other regions;
- Identify opportunities for a mine to improve its water management practices; and
- Demonstrate efforts that are being made to improve water resources management, thereby addressing the concerns among the local community about the mining sector's capacity to manage water resources.

3.1 Water balance metrics

Water balance metrics summarize the overall volume and quality of water flowing to/from a mine site within a given time period. To ensure consistent reporting across VCP signatories, the Secretariat has developed a consistent framework for water reporting. The framework is based on the Water Accounting Framework (WAF) (MCA, 2012) from The Minerals Council of Australia (MCA), which has been robustly tested across Australian mining companies and is widely used by many MCA members. The WAF is also consistent with the water reporting guidelines released by the International Council of Mining and Metals in March 2017 (ICMM, 2017), to which all ICMM members are required to comply.

These reporting frameworks distinguish three types of flows (Figure 2) to/from a mine site:

- *Inputs* – Water that enters an operational facility, that is intended for use within the facility.
- *Outputs* – Water removed from an operational facility after it has been used, e.g. for ore processing, dust suppression, mining.
- *Diversion* – Water that flows from an input to an output without being used. For example, pit dewatering would be classified as a diversion if this water is immediately reinjected to groundwater without being used for operations[1].

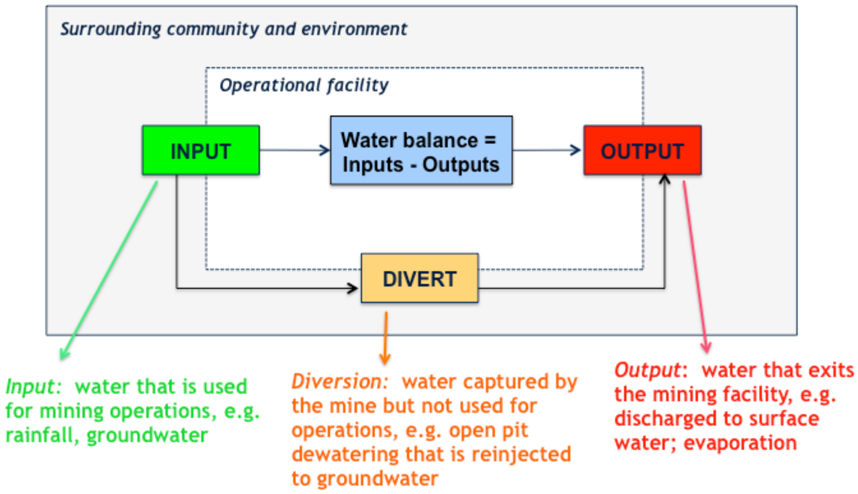

Figure 2. A water balance describes the flows of water to/from the operational facility, and the changes in storage during a specified time period. It must always be calculated during a specified time period (e.g. January to December 2017). Image adapted from the MCA Water Accounting Framework (MCA, 2012)

[1] Discussions with local mining companies suggest that Mongolian legislation charges mining companies for the total water that they extract, regardless of whether this water is diverted and not used within operations. We suggest that it would be useful for companies to make this distinction as part of VCP reporting, because it may improve understanding among communities and governments about how water is used by mining sites.

For reporting under the VCP, two input categories (Table 1) and three output categories are distinguished (Table 2)[2]. The same categories are used to classify diversions. Companies may not directly measure each of these flows (e.g. through a flow-meter). In these cases, several approaches can be taken to estimate or simulate (using a mathematical model) these numbers. The WAF user guide (MCA, 2012; p.15-20) provides guidance on how this can be achieved, and some key equations are summarized in Annex 2 of this user guide. Examples of typical metrics from other mining sites are presented in Annex 3, offering a starting point for VCP signatories to develop Key Performance Indicators to improve their water use efficiency.

Table 1. Categories for inputs of water to the operational facility; adapted from the MCA WAF (MCA, 2012)

Input category	Input sub-category	Definition
Surface water	Rainfall and runoff	Rainfall and runoff, including snow and hail.
	External surface water storages	Water extracted from dams and lakes external to the mine site.
Groundwater	Open pit dewatering	Groundwater that is extracted as part of ore body dewatering during mining operations.
	Bore fields	Bore water specifically accessed for water supply
	Water locked in ore feed	Water entrained within the ore to be processed.
Other (define)		This category can be used to specify a flow of water that does not fall under the above categories listed.

Table 2. Categories for outputs of water from the operational facility; adapted from the MCA WAF (MCA, 2012)

Output	Output sub-category	Definition
Surface water	Discharge to surface water	Uncontrolled or controlled discharge to rivers or creeks.
Groundwater	Seepage from storage facilities	Seepage from unlined storage facilities on the mine site.
Other	Evaporation from water storage dams and process ponds	Total evaporation from across all of the storage dams and process ponds on the site
	Evaporation from tailings dam	Total evaporation from the tailings dam
	Dust suppression	Total amount of water used for dust suppression across all roads on the site
	Water locked in waste streams	Water that is trapped within the tailings and course reject waste streams (this is calculated based on the moisture content – see Annex 1)
	Water locked in product concentrate	Water that is trapped within product concentrate (this is calculated based on the moisture content – see Annex 1)
Other (define)		This category can be used to specify a flow of water that does not fall under the above categories listed.

For each input of water, companies must indicate whether the water source is also used by community. This provides an indication about the quality of water and whether there is local competition over the water source. Additionally, for each output of water, companies must indicate if any discharge water quality exceeded applicable water quality threshold.

3.2 Water use efficiency metrics

The annual VCP survey also asks sites to report the efficiency of mine site water use:

5. Volume of water used per mine resident (non-operational mine)
6. Percentage[3] of water recycled and re-used at the mine/project

provides the reporting template for Mine Water Use and Water Use Efficiency metrics that was included in the 2017 annual VCP compliance survey.

[2] Several of the input and output categories used by MCA and ICMM were deemed not to be relevant for VCP signatories (e.g. sea water) and were therefore removed from the reporting template to prevent confusion.

[3] The original VCP considered the overall volume of recycling/re-use, however we suggest that this should rather consider the percentage. Signatories should consult relevant user guides to calculate this metric (MCA, 2012)(ICMM, 2017).

provides the reporting template for Mine Water Use and Water Use Efficiency metrics that was included in the 2017 annual VCP compliance survey.

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Table 3. Reporting template for Water Use by the Mine Site under the Voluntary Code of Practice

Total storage volume[4] (m^3) at start of reporting period	
Total storage volume (m^3) at end of reporting period	

INPUTS-OUTPUTS

Input-Output	**Source/ Destination**	**Inputs/Outputs**	**Volume (m^3/year)**	**Indicate if the water source is used by community**	**Indicate if any discharge water quality exceeded applicable water quality threshold**
Input	Surface Water	*Rainfall and Runoff*			
		External surface water storages			
	Groundwater	*Open pit dewatering*			
		Bore Fields			
		Water locked in ore concentrate			
	Other	*Other (define)*			
	TOTAL INPUTS				
Output	Surface Water	*Discharge to surface water*			
	Groundwater	*Seepage from storage facilities*			
		Reinjection			
	Other	*Evaporation from water storage dams and process ponds*			
		Evaporation from tailings dam			
		Dust suppression			
		Water locked in waste streams			
		Water locked in product concentrate			
		Other (define)			
	TOTAL OUTPUTS				

[4] Storage (ML) refers to total volume of water at start and end of reporting period. This is a key piece of information for the overall site water balance, i.e. the water inputs minus outputs should equal the change in storage volume.

DIVERSIONS*

Input	Surface Water	*Precipitation and Runoff*			
	Groundwater	*Open pit dewatering*			
	TOTAL DIVERSION INPUTS				
Output	Surface Water	*Discharge*			
	Groundwater	*Reinjection*			
	Other	*Other (define)*			
	TOTAL DIVERSION OUTPUTS				

Water use efficiency metrics:

Volume of water used per mine resident (non-operational mine) *[L/resident/day]*	
Water recycled and re-used at the mine/project *[percentage recycled]*	

4 State of the surrounding water systems

Metrics relating to the state of surrounding water systems is essential to address community *fears that mining will impact the quantity and quality of water available to local residents* through the following:

- By improving public knowledge about the overall condition of surface and groundwater systems within the South Gobi region; and
- By generating the information needed to address community concerns regarding how mining could be impacting water quantity and quality within the region.

As part of the 2012 Water Law, mining companies are already required to report water monitoring data to the Mongolian government on a regular basis through Annual Environmental Monitoring Reports. This information is valuable for understanding the local level impacts of mining operations. For example, Oyu Tolgoi LLC produces an annual report explaining fluctuations in water level and changes in chemical composition within the water monitoring boreholes and herder wells surrounding the mine (Oyu Tolgoi LLC, 2013). A limitation of the current reporting approach is that it focuses on the impacts of individual mines, and lacks an overall picture of the state of water systems within the South Gobi region. Additionally, data in Annual Environmental Monitoring Reports is reported in PDF documents rather than Excel files which would facilitate data analysis.

To address these gaps and improve the overall state of knowledge about surface and groundwater systems in the South Gobi, the roundtable Secretariat has been engaging with government actors to consider how data from VCP signatories could be better integrated with existing public water monitoring databases. Currently, the Secretariat is engaging most actively with the local River Basin Administrations (RBAs), who have attended several roundtable meetings and explained the importance of reliable water monitoring data for their work.

4.1 Water Monitoring template

In collaboration with local RBAs, the roundtable Secretariat have been developing a template for water monitoring data. Table 4 summarizes the preliminary list of data that RBAs identified as important to capture for water monitoring point, and a draft reporting template is provided in Table 5. The Secretariat is still in discussions with the RBAs to confirm how often companies should complete this template and to whom it should be provided.

Table 4. Metrics that are to be provided for each surface and groundwater monitoring point.

Metrics	***Explanation***
Monitoring site ID	Monitoring point ID as the company and RBA named
Data source	Company and RBA provided with information and data
Location (Latitude)	Latitude parameters of site geography Deg:Min:Sec
Location (Longtitude)	Longtitude parameters of site geography Deg:Min:Sec
Elevation	Elevation of monitoring point (From well head in metres)
Date (yy/mm/dd)	Date of record at the point
Type of water resource (Surface /Groundwater)	Note on what type of water resources monitoring
Temperature	Temperature at monitoring point
Mineralization	Mineralization at monitoring point
Electric conductivity EC	EC at monitoring point
pH	pH at monitoring site
Static level	Static level of the well (from well head)
Well radius	Radius of monitoring well (mm)
Depth (m)	Depth of monitoring well /m/
Total amount of suspended solids (mg/L)	Total amount of suspended solids at monitoring site (Milligram per litre)

Table 5. Draft water monitoring template for exchanging data with local River Basin Administrations (RBA)

Monitoring site ID	*Data source*	*Location (Latitude)*	*Location (Longitude)*	*Elevation*	*Date (yy/mm/dd)*	*Type of water resource (Surface /Groundwater)*	*Temperature*	*Mineralization*	*Electric conductivity EC*	*pH*	*Static level*	*Well radius*	*Depth (m)*	*Total amount of suspended solids (mg/L)*

References

Global Green Growth Institute, 2015, *Assessment of National Water Database of Mongolia*, prepared as part of the Water-Green Growth Nexus Project.

ICMM, 2017. *A practical guide to consistent water reporting*. Available at: https://www.icmm.com/website/publications/pdfs/water/170315_water-reporting-guidance_en.pdf

Minerals Council of Australia (MCA), 2012, *Water Accounting Framework for the Minerals Industry: User Guide*, prepared by the Sustainable Minerals Institute and the Minerals Council of Australia. Available at: http://www.minerals.org.au/file_upload/files/resources/water_accounting/WAF_UserGuide_v1.2.pdf

Mudd, G.M., 2008, *Sustainability Reporting and Water Resources: a Preliminary Assessment of Embodied Water and Sustainable Mining.* Mine Water Environ (2008) 27:136–144

Oyu Tolgoi LLC, 2013, *Implementation of the environmental protection plan and environmental monitoring program by 6709A license holder at Oyu Tolgoi deposit*. Available at: http://ot.mn/reports/environment/

Silvester, N., 2006. Appendix D: WaterMiner User Manual in: Moran, C. (Ed.), Northern Bowen Basin water and salt management practices. Centre for Water in the Minerals Industry. Available at: http://www.acarp.com.au/abstracts.aspx?repId=C15001, Accessed 22/5/2013

Annex 1 – Original set of metrics committed to by VCP signatories

Table 6. Overview of the 12 specific metrics to be reported under VCP 1.1

Metric	Mongolian Regulatory Reference
Groundwater level and flow monitoring	
Surface water level and flow monitoring	
Rainfall and climate monitoring	
Monitoring of local herder wells or springs near project site	
Monitoring quality of local drinking water source	
Water (ground/surface) quality monitoring around mine/camp site • *Note water quality indicators to be defined with Roundtable companies*	MNS 6148-2010 Groundwater Contaminant Maximum Permissible Content MNS 900-2005 Drinking Water Standard
Pit dewatering	
Volume of water used per mine resident (non-operational mine)	
Total water withdrawal per aquifer or per source (M^3/h) per year at mine site/camp and water balance of the company	GoM fees are determined based on type of use. See Government Resolution 351 of 2009 regarding Water Use Rates
Quality of mine water use	
Wastewater treatment and discharge	MNS 4943-2011 Effluent Water Standard Mine water discharge limits (TDS/EC)
Total volume of water recycled and re-used at the mine/project site	

Annex 2 – Suggested equations for estimating inputs/outputs

This Annex presents equations that companies may use to estimate key inputs and outputs of water to/from the mine site when these flows are not directly measured. For more detailed information, companies should consult the WAF[5] user guide from the Minerals Council of Australia (MCA, 2012; especially p.15-20).

[5] Note that the WAF distinguishes between raw water stores (which receive only fresh water) and worked water stores (which capture reused/recycled water), but for the sake of simplicity we do not make that distinction for reporting under the VCP.

Table 7. Suggestions for estimating input and output flows of water to/from operational facility; adapted from the MCA WAF (MCA, 2012)

Input category	Input sub-category	Equation
Surface water	Rainfall and runoff	Rainfall entering a storage dam, $V_{Rainfall}$ (m^3/year) = 0.001 x R x SA_{ntore} where R is the rainfall measured during the reporting period (mm/year) and SA is the combined surface area of all water storage dams on the site that are open to the atmosphere (m^2) Runoff entering a mine site, $V_{Runoff,}$ (m^3/year) = 0.001 x R x A x β where R is the rainfall measured during the reporting period (mm/year), A is the catchment area (m^2) and β is a volumetric rainfall/runoff factor.
	External surface water storages	*Should be directly measured by flow-meter, or may be estimated by engineers based on pump rates.*
Groundwater	Aquifer interception (dewatering)	*Should be directly measured by flow-meter, or may be estimated by dewatering technicians based on pump rates.*
	Bore fields	*Should be directly measured by flow-meter, or may be estimated by dewatering technicians based on pump rates.*
	Ore entrainment	The volume of water that is entrained in the ore V_{ent} (m^3/year) can either be known or estimated. To calculate this: V_{ent} = 1000 x P x 1/D x M where P is the incoming ore processed in the reporting period (Mt/year), D is the density of the ore (Mt/m^3) and m is the moisture content as a fraction.

Table 8. Categories for outputs of water from the operational facility; adapted from the MCA WAF (MCA, 2012)

Output	Output sub-category	Definition
Surface water	Discharge	*Should be directly measured by flow-meter, or may be estimated by dewatering technicians based on pump rates.*
Groundwater	Seepage	May assume that the storage dam would lose 0.014% of its current volume at each daily timestep, as per Silvester (2006).
	Reinjection	*Should be directly measured by flow-meter, or may be estimated by dewatering technicians based on pump rates.*
Other	Evaporation	Evaporation loss, V_{Evap} (m^3/year) can be estimated by: V_{Evap} = 0.001 x SA_{Evap} x PanEvap x f SA_{Evap} is the average surface area (m^2) occupied by water across all storages during the reporting period, and should be estimated based on information about the geometry of the store (to understand how SA_{Evap} varies with the depth of water) and water levels during the reporting period. PanEvap is the rate of pan-evaporation (mm) during the reporting period. f is a correction factor to convert measurements of pan evaporation into evaporation losses from open storages. For pan evaporation rates measured with a Class A pan, MCA (2012) suggest a correction factor of around 0.75.
	Entrainment	The volume of water that is entrained in the ore V_{ent} (m^3/year) can either be known or estimated. To calculate this: V_{ent} = 1000 x P x 1/D x M where P is the flow of outgoing ore in the reporting period (Mt/year), D is the density of the ore (Mt/m^3) and m is the moisture content as a fraction. Entrainment should be calculated both for the product and the tailings waste material.

Annex 3

The below table summarizes information about water consumption (kL/tonne ore) for different commodities, taken from Mudd (2008). Oyu Tolgoi have used the information from this study to benchmark their site performance, and a similar approach may also be relevant for other mining sites operating in the South Gobi.

Table 9. Summary data for water consumption across different mineral commodities. Reproduced from Mudd (2008)

Mineral/metal	**Years of data**	**v. ore throughput (e.g. kL/t ore)**		**v. ore grade (e.g. kL/t metal)**	
		Average	Standard Deviation	Average	Standard Deviation
Bauxite (kL/t bauxite)	17	1.09	0.44	-	-
Black coal (kL/t coal)	18	0.30	0.26	-	-
Copper (kL/t ore; kL/t Cu)	48	1.27	1.03	172	154
Copper-gold (kL/t ore; kL/t Cu)	42	1.22	0.49	116	114
Diamonds (kL/t ore; kL/carat)	11	1.32	0.32	0.477	0.170
Gold (kL/t ore; kL/kg Au)*	311*	1.96*	5.03*	716*	1,417*
Zinc/lead/silver/copper/gold (kL/t ore; kL/t Zn/Pb/Cu)	28	2.67	2.81	29.2	28.1
Nickel (sulfide) (kL/t ore; kL/t Ni)	33	1.01	0.26	107	87
Platinum group (kL/t ore; kL/kg PGM)	30	0.94	0.66	260	162
Uranium (kL/t ore; kL/t U_3O_8)	24	1.36	2.47	505	387

* If one mine is removed from the data, the average and standard deviation become 1.372 and 1.755 kL/t ore and 609 and 1,136 kL/kg Au, respectively.